Opportunistic Clusters Selection in a Reliable Enhanced Broadcast Protocol for Vehicular Ad hoc Networks

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Introduction to VANETs (Vehicular Ad-hoc NETworks)
- Safety applications
- V2V / V2I communications

Open issue
- Broadcast Storm Problem in VANETs

Proposed technique – Selective Reliable Broadcast
- Main aspects
- Simulation results
- Comparison to traditional broadcast protocol

Conclusions
**VANET – An overview**

VANETs are a particular class of MANETs, enabling short and long range vehicular communications.

**Objectives:**
- To reduce traffic congestions and accidents;
- To provide higher safety level;
- To create a digital “smart” car.

**Main aspects:**
- Dynamic network topology
- Short-life connectivity links
- Smart vehicles with On-Board Unit equipment
- Data traffic dissemination with opportunistic networking


**Data Dissemination via V2V/V2I**

- **Short-range** communications between vehicles (V2V)
- **Long-range** communications from vehicles to the network infrastructure (V2I)

**Different Scenarios**
- **Urban**
- **Rural**
- **Highway**
Broadcasting packets may lead to frequent contention and collisions in transmission among neighboring vehicles.

- This affects inter-vehicle communications, with increasing redundant rebroadcasts, contention and collisions.

**How to reduce (or at least mitigate) this problem?**

- By introducing intelligence to the basic broadcast concept and make it more **selective** and, thus, more efficient in its resource usage;
- The selectivity feature is given by the **clusters partitioning** in a VANET.

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**SRB – Selective Reliable Broadcast**

- SRB is a distance and cluster-based routing protocol.

**Main Objective**

- To avoid the *broadcast storming problem*;
- To detect clusters of vehicles in a fast and automatic mode (*car platooning*);
- To increase safety on the roads.

**Main Features**

- Distance-based iterative algorithm to detect clusters;
- Cluster identification to transmit packets only to one vehicle per cluster (opportunistically elected as cluster-head).

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**Clusters of vehicles**

Source: http://www.path.berkeley.edu/PoX/PoXPublications/Media/FastShoe/vehPlatooning.pdf
SRB – Cluster Detection

• SRB considers a contention resolution procedure to detect nearby clusters, and then elects CH nodes:
  a) RTB transmission
  b) CTB transmission
  c) Cluster detection and CH election
  d) Message propagation
SRB – Algorithm (2/2)

- How do vehicles send CTB messages?
  - Vehicles compute their distance from the source vehicle. It is then exploited for the waiting time calculation, depending on maximum and minimum contention window:
    \[ t_w = \frac{r_{tx} - d}{r_{tx}} (CW_{max} - CW_{min}) + CW_{min} \cdot t_{slot} \]
  - Vehicles in the further regions always transmit before the others.

Simulation setup – Used Tools

- Validation of SRB’s effectiveness in urban environment
- Network performance
  - Throughput [bit/s]
  - Message propagation [m]
- Performance comparison with broadcast protocol
**Features**

- 4 km² area
- Dense traffic scenario
- Vehicle cluster aggregation in a random fashion, due to not homogeneous nature of the scenario (i.e., presence of junctions and traffic lights can reduce cluster formation).

- Simulation time: 100 s
- IEEE 802.11b
  - Data rate: 6Mbps
  - Range: 300 m

**Simulation results**

Throughput

- Throughput peaks > 30 kbit/s
- 45% vehicles involved in the data transmission

- Throughput peaks < 5 kbit/s
- Increase of message replica.
Simulation results (2/3)

Message Propagation

- Average long distances reached (up to 1.3 km far from the source).
- The vehicular environment is almost fully “covered”.
- Limited distances reached (<300 m far from the source), mainly due to the number of collisions and the packet drop probability.

Conclusions

SRB is a Selective Reliable Broadcast protocol aiming:
- To alleviate the broadcast storm problem
- To detect car platooning in automatic way
- To save network resources while keeping high performance.

SRB effectiveness has been validated in a urban real scenario and compared to traditional broadcast protocol.

Future work:
- Exploiting the use of SRB into context-aware applications.
Thank you for your attention!